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EXPERIMENTAL INDUCTION OF THE MYCOSIS CAUSED BY *ENTOMOPHTHORA MUSCAE* IN A POPULATION OF HOUSE FLIES (*MUSCA DOMESTICA*) WITHIN A POULTRY BUILDING

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Abstract.—Color-marked house flies (*Musca domestica*) with advanced infections of *Entomophthora muscae* were added to a test group of healthy young adult flies within a poultry building. About 6 to 8 days after the flies in the marked-infected group died, those in the test group also died. Cadavers of flies that succumbed to the infection were found on various surfaces within the building. This probably serves to promote the distribution of infective conidia within the general environment. Deaths attributable to the mycosis in the test group probably approached or reached 100%. It is suggested that *E. muscae* can be used to control house flies in the field.

While spectacular natural epidemics of the mycosis caused by *Entomophthora muscae* in populations of *Musca domestica* have been reported in the literature for decades (see Greenberg, 1973; West and Peters, 1973), the exploitation of this fungus in the biological control of house flies has received little consideration. In the literature available to us we found only two previous studies that center on the use of *E. muscae* for house-fly control. Schweizer (1936) added small chunks of an *in vitro* culture of a fungus he identified as *E. muscae* to saucers of milk and sugar. These dishes were placed in stables, and the harmful effects on house flies were noticed within a short time. Unfortunately the methods he used to culture the fungus and to measure the impact of the contaminated sugar-milk on populations of flies are described only briefly. Vogel (1968) also cultured a fungus he identified as *E. muscae* on a special substrate. Pieces of fresh mycelium from these cultures set out in animal buildings were said to have caused rapid mortality within house-fly populations. How he conducted his field tests and measured his results is not given. Here we discuss our attempt to induce the fatal disease caused by *E. muscae* in a previously disease-free population of house flies under field conditions. The results not only contribute to our understanding of the epidemiology of the mycosis caused by *E. muscae,* but also clearly demonstrate that this fungus could be used to control house flies in the field.

MATERIALS AND METHODS

The test site. The poultry building selected for the experiment was one of eight similar structures (each about 4 m wide, 3 m deep and 2.5 m high) located on a sunny and well-drained field of closely mown grass at Cornell University's Poultry Research Farm 2, Ithaca, New York (Fig. 1). Large screened windows covered the upper portion of the front of the house. The rear wall was windowless. One side of

Table 1. The fate of marked-infected flies and test flies: the spatial distribution of their cadavers and the prevalence of *Entomophthora muscae* infections among them.

Sites	Marked-infected flies[1]		Test flies[2]	
	# (%)	% infected	# (%)	% infected
Floor	104 (53)	100	169 (49)	88
Feeder	57 (29)	100	38 (11)	100
Strings	28 (15)	100	85 (25)	93
Walls	5 (2)	100	38 (11)	100
Ceiling	3 (1)	100	12 (4)	100
Totals	197 (100)	—	342 (100)	—

[1] Excludes about 50 flies not recovered at end of test.
[2] Excludes about 100 flies not recovered at end of test.

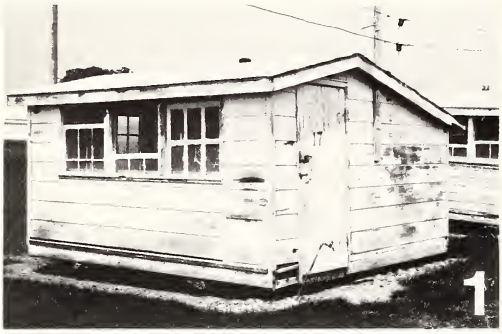
the house was fitted with a large hinged door, while the other side contained but one small screened window. The floor was solid except for several small and inconspicuous holes, undoubtedly the handiwork of mice. Traces of chicken droppings, feathers, spilt chicken feed, cobwebs and dust covered parts of the walls and floor. This refuse was removed to maximize our chances for successfully following the fate of the flies used in this study. We also felt that a relatively clean building might discourage the activities of Canadian deer mice (*Peromyscus maniculatus gracilis*) known to occur in the area. Eight strings of cotton twine about a meter in length were suspended from the ceiling to provide the flies with additional resting sites. This test was conducted in early August when natural *E. muscae* infections are uncommon in the Ithaca area. It is a period generally characterized by warm sunny days with little rainfall and warm to cool nights.

Source of inoculum. A group of about 250 healthy insectary-reared house flies was inoculated with our strain of *E. muscae* by a method described elsewhere (Kramer and Steinkraus, 1981). The flies were next held in the laboratory for about four days. They were then lightly anesthetized with carbon dioxide and the dorsa of their thoraxes marked with a dab of fast-drying nontoxic red paint. Since we had established that diseased flies generally die of the mycosis between post-exposure days 5 and 8 under laboratory conditions, we knew that these marked-infected flies would die within three days from the start of the field study.

Procedures. The marked-infected flies, plus a test group of about 400 young flies from a disease-free insectary colony, were released within the chicken house. This mixed population of flies was observed daily through the screened windows. A feeder consisting of a large tray containing a mixture of dried milk and sugar, plus a water fountain, was placed in the house to sustain the flies. At the end of the experiment, cadavers associated with various surfaces were counted and categorized as given in Table 1. Only specimens displaying typical post-mortem changes were scored as infected (see Fig. 3).

RESULTS AND DISCUSSION

Observations made over the first three days of the experiment revealed that some flies from both the test group and the marked-infected group had died on the floor or had fallen to the floor after dying. By the eleventh day there were no signs of



Figs. 1–4. 1. Poultry building used in this study. 2. Cadavers of flies from the test group affixed to a substrate and displaying various stages of the post-mortem changes associated with the mycosis. 3. Two test-group cadavers from which showers of conidia are being produced. Note whitish layer of conidia covering under surface of the wing of the fly at the right. 4. Adult Canadian deer mouse eating cadavers of flies with *E. muscae* outgrowths. This mouse was trapped at the test site and fed cadavers in the laboratory without any ill effects.

movement or flight observable through the screened windows, and we entered the building. A careful search yielded no living flies. Intact cadavers were found on the ceiling, walls, strings and the feeder (Figs. 2, 3). A mixture of whole cadavers, piles of wings and legs, plus fecal pellets from mice, was found on the floor. About 80% of the flies within each group was recovered. In all likelihood the carcasses of the missing flies had been eaten by mice that had entered the building through the small holes in the floor (see Fig. 4).

The spatial distribution of cadavers within both groups is given in Table 1. In each case about 50% of the flies had died on or fallen to the floor, while another 35 to 40% had died on the strings or the feeder. Only 10 to 15% were found on the walls and ceiling. Clearly all surfaces frequented by healthy flies may also serve as final roosting sites for individuals that succumb to the mycosis. This might promote a rather good distribution of infective conidia within the general environment.

While 100% of the cadavers recovered from the marked-infected group displayed the characteristic post-mortem changes associated with the mycosis, only 92% of the cadavers from the test group did so. The collection of dead flies lacking typical post-mortem changes was not studied in detail. A majority of them, however, probably had died within the first few days of the experiment and thereby escaped the mycosis. Hence, the actual incidence of fatal *E. muscae* infections in flies that had lived for seven to nine days within the test group probably approached or reached 100%.

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